

COMPLETE LISTING OF CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1-37 (canceled)

38. (currently amended) ~~In a~~ direct expansion (“DX”) geothermal heat exchange system, having a DX geothermal heat pump operable in a heating mode and including a sub-surface geothermal heat exchanger comprising sub-surface refrigerant tubing positioned to allow primary geothermal heat transfer directly to refrigerant fluid circulating in the sub-surface refrigerant tubing, an improvement~~the system further comprising~~ a supplemental solar heating system including a solar heat collector fluidly connected to a solar heat to direct expansion system refrigerant fluid heat exchanger by fluid transport tubing, wherein solar heat acquired from the solar heat collector is conveyed by means of a fluid within the fluid transport tubing, and the solar heat is transferred by the solar heat to direct expansion system refrigerant fluid heat exchanger to the refrigerant fluid in the DX geothermal heat pump.

39. (previously presented) In a geothermal direct expansion (“DX”) heat exchange system, having a DX geothermal heat pump operable in a heating mode and including a sub-surface geothermal heat exchanger, an improvement comprising a supplemental solar heating system including a solar heat collector fluidly connected to a solar heat to direct expansion system refrigerant fluid heat

exchanger by transport tubing, wherein solar heat acquired from the solar heat collector is conveyed by means of a fluid within the transport tubing, and the solar heat is transferred by the solar heat to direct expansion system refrigerant fluid heat exchanger to refrigerant fluid immediately prior to the refrigerant fluid entering the sub-surface geothermal heat exchanger.

40. (previously presented) The system of claim 38 wherein the fluid transport tubing between the solar heat collector and the solar heat to refrigerant fluid heat exchanger is insulated, and wherein the exterior of the solar heat to refrigerant fluid heat exchanger is insulated.

41. (previously presented) The system of claim 38 wherein the solar heat to refrigerant fluid heat exchanger is located at an elevation above that of the solar heat collector.

42. (previously presented) The system of claim 38 further comprising a solar heat transfer termination device, which solar heat transfer termination device is activated only when the DX geothermal heat exchange system is operating in a cooling mode, and during periods of time when supplemental heat supplied by the solar heat collector is at a lower temperature than a maximum temperature in the sub-surface geothermal heat exchanger.

43. (previously presented) A direct expansion geothermal heat exchange system, operating in the heating mode, comprising a supplemental solar heating system wherein heat acquired from a solar heat collector is conveyed by means of a fluid within transport tubing, and the solar heat is transferred, by a solar heat to

direct expansion system refrigerant fluid heat exchange means, to the refrigerant fluid in a direct expansion system, wherein the solar collector's heat transfer tubing is always sloped in an upward vertical orientation from the bottom of the solar heat collector to the top of the solar heat to direct expansion refrigerant fluid heat exchange means, and wherein the solar collector's heat transfer tubing is always sloped in a downward vertical orientation from the top of the solar heat to direct expansion refrigerant fluid heat exchange means to the bottom of the solar heat collector.

44. (previously presented) The system of claim 38 further comprising refrigerant tubing fluidly connected to the solar heat to direct expansion refrigerant fluid heat exchanger, the refrigerant tubing including an inverted U bend.

45. (previously presented) A direct expansion geothermal heat exchange system, operating in the heating mode, comprising a supplemental solar heating system wherein heat acquired from a solar heat collector is conveyed by means of a fluid within transport tubing, and the solar heat is transferred, by a solar heat to direct expansion system refrigerant fluid heat exchange means, to the refrigerant fluid in a direct expansion system, wherein the solar heat to direct expansion refrigerant fluid heat exchange means is situated at a point in the direct expansion system's liquid refrigerant transport line after the direct expansion system's heating mode refrigerant expansion device and before the point where the direct expansion system's thermally exposed sub-surface refrigerant transport geothermal heat exchange tubing is located.

46. (withdrawn) A closed-loop water-source geothermal heat pump system, operating in the heating mode, comprising a supplemental solar heating system wherein heat acquired from a solar heat collector is conveyed by means of a fluid within transport tubing, and wherein the solar heat is transferred to the one of water and water and antifreeze fluid circulating within the closed-loop water-source geothermal heat pump system by means of one of a solar heat to a water-source system water/antifreeze fluid heat exchange means, and a solar heat to water-source system refrigerant fluid heat exchange means to a water-source system refrigerant fluid to water-source system water/antifreeze fluid heat exchange means.

47. (withdrawn) A closed-loop water-source geothermal heat pump system, operating in the heating mode, comprising a supplemental solar heating system wherein heat acquired from a solar heat collector is conveyed by means of a fluid within transport tubing, and wherein the solar heat is transferred to the one of water and water and antifreeze fluid circulating within the closed-loop water-source geothermal heat pump system by means of one of a solar heat to a water-source system water/antifreeze fluid heat exchange means, and a solar heat to water-source system refrigerant fluid heat exchange means to a water-source system refrigerant fluid to water-source system water/antifreeze fluid heat exchange means immediately before the water-source system's circulating water/antifreeze fluid enters the sub-surface geothermal heat transfer environment of the water-source system.

48. (withdrawn) The system of claim 46 wherein all solar heat fluid transport tubes between the solar heat collector and the one of solar heat to water/antifreeze fluid heat exchange means, and solar heat to refrigerant fluid heat exchange means to a refrigerant fluid to water/antifreeze fluid heat exchange means, are insulated, and where the exteriors of the one of solar heat to water/antifreeze fluid heat exchange means, and solar heat to refrigerant fluid heat exchange means to a refrigerant fluid to water/antifreeze fluid heat exchange means, are insulated.

49. (withdrawn) The system of claim 46 wherein the one of a solar heat to water/antifreeze fluid heat exchange means, and solar heat to refrigerant fluid heat exchange means and a refrigerant fluid to water/antifreeze fluid heat exchange means is provided, and wherein the one of solar heat to water/antifreeze fluid heat exchange means, and solar heat to refrigerant fluid heat exchange means, is located at an elevation above that of the solar heat collector.

50. (withdrawn) The system of claim 46, wherein a solar heat transfer termination means is provided, which solar heat transfer termination means is only activated when the water-source heat pump heating and cooling system is operating in the cooling mode, and during periods of time in the heating mode when the supplemental heat supplied by the solar heat collector is at a lower temperature than the maximum temperature in the geothermal heat exchange sub-surface environment, and which solar heat transfer termination means is otherwise deactivated.

51. (withdrawn) The system of claim 46 wherein there is an inverted U bend in the water-source heat pump's heating system's one of water/antifreeze fluid transport tubing, and refrigerant fluid transport tubing, which tubing containing the inverted U bend is situated above the one of solar heat to water/antifreeze fluid heat exchange means, and solar heat to refrigerant fluid heat exchange means.

52. (withdrawn) The system of claim 46 wherein the solar collector's heat transfer tubing is always sloped in an upward orientation from the bottom of the solar heat collector to the top of the one of the solar heat to water/antifreeze fluid heat exchange means, and solar heat to refrigerant fluid heat exchange means, and wherein the solar collector's heat transfer tubing is always sloped in a downward orientation from the top of the one of the solar heat to water/antifreeze fluid heat exchange means, and solar heat to refrigerant fluid heat exchange means, to the bottom of the solar heat collector.

53. (withdrawn) A direct expansion geothermal heat pump system supplemental refrigerant vapor line cooling means comprising:

a compressor operatively connected to the refrigerant vapor line; and
an interior heat exchange means operatively connected to the refrigerant liquid line and to the compressor.

54. (withdrawn) The system of claim 53 wherein condensate water generated by operation of the interior heat exchange means is supplied in a manner so as to be in thermal contact with one of the refrigerant vapor line and an expanded surface

area refrigerant vapor line segment to promote evaporative cooling of the refrigerant vapor line.

55. (withdrawn) The system of claim 53 wherein water from any source is supplied in a manner so as to be in thermal contact with one of the refrigerant vapor line and an expanded surface area refrigerant vapor line segment to promote evaporative cooling of the refrigerant vapor line.

56. (withdrawn) A closed-loop water-source geothermal heat pump system supplemental refrigerant vapor line cooling means comprising:

a compressor operatively connected to the refrigerant vapor line; and

an interior heat exchange means operatively connected to the refrigerant liquid line and to the compressor.

57. (withdrawn) The system of claim 56 wherein condensate water generated by operation of the interior heat exchange means is supplied in a manner so as to be in thermal contact with one of the refrigerant vapor line and an expanded surface area refrigerant vapor line segment to promote evaporative cooling of the refrigerant vapor line.

58. (withdrawn) The system of claim 56 wherein water from any source is supplied in a manner so as to be in thermal contact with one of the refrigerant vapor line and an expanded surface area refrigerant vapor line segment to promote evaporative cooling of the refrigerant vapor line.

59. (currently amended) A geothermal heat exchange system, operating in the heating mode, comprising:

a geothermal heat pump, the geothermal heat pump including system refrigerant tubing and system refrigerant moving through the refrigerant tubing;

wherein at least a portion of the system refrigerant tubing is positioned in a sub-surface location to allow for primary geothermal heat transfer directly into the system refrigerant;

a supplemental solar heating system, the supplemental solar heating system including a solar collector, solar heating transport tubing thermally coupled to the solar collector, and solar heating fluid moving within the solar heating transport tubing;

a heat exchanger thermally coupled to the supplemental solar heating system and to the geothermal heat pump; and;

wherein heat acquired from the solar collector is conveyed to the solar heat heating fluid within the solar heating transport tubing, and the solar heat is then transferred by the heat exchanger to the system refrigerant in the system refrigerant tubing.